Review and Evaluation Criteria for Software Tools Supporting the Implementation of the RCM Methodology

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Abstract-This paper tries to help industrial organizations in the process of RCM software tools characterization and evaluation. We first review different types of software platforms structures that support the RCM methodology implementation and then we propose a series of benchmarks to assess, weigh and compare these types of tools, concentrating on essential methodological issues that must be met for successful implementation of RCM methodology in any organization. The structure, main features and functionalities of three different platform proxies are described. This is done in order to characterize the various operating structures of these kinds of software tools, but also to facilitate the comparison among them through a descriptive and practical tabular analysis using a referred maturity model.

Keywords-Maintenance,RCM, software, evaluation methodology, maturity model, information systems

I. INTRODUCTION

The occurrence of industrial equipment failures and breakdowns is a major cause of inefficiency. Its occurrence may cause a decrease in the availability of the processes [1] that lead to an increase in operating costs and a loss of revenue or even in some cases, can cause an accident resulting in significant damage to people or to the environment [2].

The more or less intrinsic resistance to failure of any device is measured by its reliability, R(t), at a given time t, represents the probability that the device develops a required function under given conditions in a time interval given (0, t] [3], provided that the device was in perfect condition at the initial time. The equipment failures are always a probability of occurrence and their impact may be higher or lower, according to different factors intrinsic and extrinsic to the facility. Considering this fact, two new concepts related to the reliability have an extremely important in the operation of any device, availability and security.

The availability of a device measures its ability to meet the demand for performance under certain conditions in a given instant or during a specified time, assuming that the required external resources are provided [3].

The security of a device measured its ability to operate without causing damage. The concept of security is closely linked to reliability [3, 4], where the generation potential of damage should only be associated with the occurrence of a failure, never with the proper functioning of a device.

Throughout the life cycle of an asset, generally appear wear phenomena that decrease their intrinsic resistance to failure and, therefore, causes its reliability to decrease [5] [6]. Preventive maintenance [7, 8] seeks to control the growth of the failure rate because it caused the phenomena of wear. However, failures occur more or less and the devices become unavailable unless they are repaired. Then the corrective maintenance aims to minimize the downtime of equipment and minimize the negative impact that may occur on the availability and security of the system when a fault occurs.

Careful system reliability management should lead to optimization of its profitability by achieving maximum operational efficiency. At the time of creating alternatives to improve reliability in the operational phase of the facilities, maintenance optimization is one of the most interesting factors [9n] because its associated cost contributes in the overall operating cost.

The optimal allocation of resources between the activities of corrective maintenance and preventive maintenance [10, 11] is one of the constant concerns that should be the manager of any facility, especially when the environment on which it operates is characterized, among other aspects, by high degree of competitiveness, greater requirement for quality products and services and a growing respect for the environment.

II. RCM'S METHODOLOGY

The Reliability Centered Maintenance (RCM) is a methodology of systematic analysis, applicable to any industrial facility, very useful for the development and optimization of the maintenance strategy. This method is widely used to determine the maintenance needs of any physical asset in its operating environment [12]. It has also been defined [13] a method that identifies the function of a system, how these functions may fail, setting preventive maintenance activities.

Its basic principles were developed in the 60s for the U.S. airline industry. At the beginning of the decade of the eighties, this methodology is beginning to transfer to other industries. In 1984, EPRI (Electric Power Research Institute) identifies the RCM as a methodology is highly recommended for use in the nuclear field [14] and began a series of pilot studies that apply different methodological criteria, achieving reductions in material costs and maintenance workforce of around 30% to 40% [15], so begin to develop implementation guidelines and support tools. In the last twenty years, the implementation of the RCM methodology has been generalized to almost all industrial sectors, where it has proven to reduce the number, frequency and content of comprehensive reviews (overhauls) systems, increasing the availability of equipment and reducing

the cost of maintenance and inventory volume [16]. Today, the RCM is a standard technique [17].

The RCM proposes, as a general approach, the priority maintenance of the critical components for the proper functioning of an installation [18], allowing the not critical components to operate until its failure, at that instant the corrective maintenance will be applied. RCM takes into account the operational context of critical equipment and proposes the need of a maintenance follow-up & update program.

It is essential to correctly identify the components deemed critical [11]. To determine the criticality of an equipment must consider two aspects: their probability of occurrence and severity. The probability of occurrence measures the estimated frequency of occurrence of failure considered while the severity measures the severity of impact that this failure may cause over the installation. This assessment is usually done by the technique called "Failure Modes and Effects Analysis" (FMEA).

The RCM methodology proposes to identify the failure modes before they occur and the implementation of a systematic process for the selection of maintenance tasks [12]. The result will be a set of maintenance tasks for each equipment and failure mode. It will define the content of the specific activities that will be undertaken and their frequency. Specifically, the RCM methodology proposes a procedure [12, 19], through seven questions or steps, which can identify the real needs of maintenance in the operating context:

TABLE I. RCM METHODOLOGY

1	What are the equipments functions and what is the expected performance in the operating context?
2	How can the equipment completely or partially fail?
3	What is the cause of the functional failure?
4	What happens when a fault happens?
5	What is the consequence of each failure?
6	How can you prevent or predict the occurrence of each functional failure?
7	What can be done if it isn´t possible to prevent or predict the occurrence of the functional failure?

The RCM process is regulated through the standards SAE-JA1011 [19] and SAE-JA1012 [20]. Once selected maintenance activities considered more efficient for each critical equipment, final RCM recommendations analysis and its implementation take place.

From these final recommendations, will draft the new maintenance program or strategy proposed for the facility, allocating also the necessary resources to implementation. The implementation of the preventive maintenance program allow [21, 11] the anticipation to failures and minimal impact on system performance. It also allows eliminating the causes of some failures and to identify those failures that do not compromise the system security.

The need to consider new maintenance techniques, emerging failure modes, etc. will require periodic updating to keep current RCM analysis recommendations over time.

III. PROBLEM STATEMENT AND PURPOSE OF STUDY

To enable the practical implementation of RCM analysis on the equipment of an industrial plant, several manufacturers have developed software packages to meet all needs in this area, employing some aspects of the concept ”e-maintenance”. However, the set of software tools don’t have a defined structure, so their evaluation and comparison both quantitatively and qualitatively, is complex. For this reason, we have developed this study.

Therefore, the aim of this study is the search, analysis and description of the structure and functionality offered by today's maintenance software tools that support the implementation of RCM methodology and the definition of the policies. This work also defines an evaluation methodology for evaluating the suitability of any RCM software tool in areas such as alignment with the RCM methodology and others, facilitating the comparison between them.

Each software can use different strategies or methods of calculation, and contain different modules or subpackages depending on the strategy implemented. In general, as noted below, each integrated package offers the user several modules for different strategies analysis.

This article analyzes the possible structures that may have the RCM software platforms, with its characteristics and specific functions. A RCM software is a support tool for the management and optimal planning of equipment maintenance according to each operational context. The aim is to show all the possibilities that this type of software currently offers as support and assistance to the implementation of the RCM methodology at the organizational level, incorporating e-maintenance strategies.

IV. RCM SOFTWARE TOOLS

The RCM platforms and each software package is usually based on the RCM methodology (Table 1) to support the implementation of this method in an industrial plant. However, many of the RCM software tools have additional modules to support RAMS analysis (Reliability, Availability, Maintainability & Safety) [22, 23], based both: on reliability databases and/or on plant historical data. These additional modules can be used as a support for decision making in the overall maintenance management.

In general, all tools allow the generation of reports with the results obtained using custom formats by the users, adapting their requirements, and can in turn be stored in the database that is maintained by the software itself, and which will constitute the historical data of the industrial assets of the organization.

It is common to find tools made up of several modules, which are marketed independently and each module has its price, therefore would be possible to purchase only those modules that perform the required functions.

In the current set of RCM software, there are common operational structures for classifying RCM software tools into three types according to operational settings, e-maintenance capabilities and integration.

To facilitate structural and functional understanding of the types of structures, has made a descriptive analysis in tabular format (Table 2), which also exemplifies each type of structure with an existing software tool RCM. It has also prepared a summary of the main functions and characteristics of each structure, thus, can assess the functional and operational differences among them. It is noted that there are three types of organizational structures within the field of the RCM software:

TABLE II. KIND OF STRUCTURE EXISTING IN RCM SOFTWARE TOOLS

TYPE I INTEGRAL ARCHITECTURE	** TYPE II ** MODULAR ARCHITECTURE	** TYPE III ** MIXED ARCHITECTURE
This type of RCM software has a specific RCM analysis management module which is integrated within the CMMS (Computer Maintenance Management System) Interface, or existing database in the organization. In this way, the software does not have a separate interface for the database, but is the database itself which gives access to the RCM software tool. Type I tools define maintenance strategies based on RCM methodology and integrate the recommendations of the RCM analysis within the CMMS maintenance plans (or equivalent), generating work orders. These tools join in a single add-on module all functions related to the overall management of maintenance, those not covered by the RCM methodology. Thus, such tools have an integral architecture.	The RCM software type II, has a structure completely modular, meaning that they have an operating module for each of the functions or maintenance needs: FMEA, Weibull analysis, statistical analysis, RCM analysis, RBD (Reliability Block Diagram) and others. Each module has a separate interface for the existing database (CMMS) in the organization. However, each module can connect to the database. Normally, depending on each module, this type of structure allows the interconnection among software modules, being able to use results obtained in a particular module to make a future analysis in a separate module. These tools develop all stages proposed by the RCM methodology and to define optimal maintenance intervals. Also, these software compare the operating costs of various maintenance strategies.	The RCM software type III, has characteristics of type I and II structures. They have a single management module designed from the RCM methodology. This module does not share the interface of the existing database (CMMS), but has its own interface, capable of connecting to the database. Generally, these tools offer two modules with different coverage or level of functionality: a basic module with the main functions to support RCM analysis based on the methodology and an advanced module, more complete, which has all the functionality of the basic module and additional functional features for advanced management of RCM analysis. Both modules guide the RCM analysis process, following the methodology of the seven questions. Additionally, the advanced module enables the updating of the maintenance strategy, RCM analysis and maintenance plans by capturing real time data of critical equipment (CBM).

From an objective point of view, integral or modular architecture of RCM software should not be relevant in their functional assessment, as the architecture itself does not add functional neither methodological value to the tool.

However, both can have advantages. For example, an integrated architecture allows for easier overall management of the tool. Modular architecture allows the user to have only those modules you need, which also facilitates the management and reduces the costs of purchasing and licence.

To deepen in the analysis and description of software tools that exemplify each of the structures described above, the reader is referred to some of the articles and studies published by the authors, [22, 24, 25].

In summary, we present the main benefits to be derived from the use of software to support the implementation of the RCM methodology, whether of structure type I, II or III:

•Define the operational requirements of the facilities, equipment and systems.
•Centralize all information concerning the maintenance of equipment.
•Having a functional analysis of the assets.
•Determine the failure effects and consequences (impact) on the system, related to people safety, environment, etc.
•Define proactive actions to avoid or minimize the consequences of failure.
•Eliminate or control the failure modes causing the failure.
•Quantify the costs associated with the failures and the costs associated with preventing them.
•Provide a strategy of RCM analysis continuous improvement, able to upgrade and adapt to changing critical equipment operational scenarios.
•Eliminating unnecessary maintenance tasks and easy adjustment to optimum maintenance frequency.
•Define high-impact equipment, by ranking all existing assets.
•Build an updated maintenance database of all physical assets, improving the level of maintenance information, very important for the efficient management of maintenance in the organization.
•Improve operational control, better work management with better task request control, monitoring of delays and determination of priorities.
•Improving planning and effective scheduling of maintenance.
•Improving the management of maintenance materials, identifying and reducing excess inventory levels for non-critical equipment, adjusting the optimal levels of spare parts for critical equipment.
•Improving the reliability analysis, improving the monitoring of work orders and generating historical equipment (types of repair, frequency and causes). Provide information on failure trends, facilitating the elimination or control of the failure modes, improving equipment reliability.
•Improve overall maintenance budget control through increased local control of the maintenance budget (parts, equipment and work orders).

A. *Other Features or Additional Modules*

As noted, there are two types of structure (type I and II) in which the software tool has its own module of support to the RCM analysis, and also functional modules that complement the overall management of the reliability and maintenance physical assets. These modules provide specific functionality related to the RCM analysis or complementary to it.

Once we have reviewed the different types of existing structures in the field of software that supports the RCM methodology (Table 2), we now describe below the most

important functions they can offer in additional modules to the RCM tool (Table 3) , considering only those that can complement the RCM analysis. Therefore, these features are related in one way or another with the RCM analysis, however, there are additional features not related to RCM to give each tool differentiating features, which may be of interest in the overall assessment of the software tool.

TABLE III. ADDITIONAL FUNCTIONS FOR RCM ANALYSIS

COMPLEMENTARY FUNCTIONAL MODULES	
MODULES	**FEATURES**
*** FMEA/ FMECA**	An analysis of failure modes, effects (FMEA) and criticality (FMECA) is a qualitative method that identifies the failure modes, analyzing the consequences of failure on the system and proposes measures to avoid or minimize the consequences of the same [17]. The method analyzes the failure modes, assesses the effects and criticality (FMECA) on the system and also the probability of occurrence. Basically identifies the areas that need improvement to ensure that the system is more reliable and secure (globally) in the discharge of their functions.
*** WEIBULL**	Weibull analysis is used to adjust data to a mathematical model [17, 21]. Allows plotted using logarithmic scale failures and to represent the behavior of the element in comparison to failure.
***STATISTICAL COMPUTATION AND SIMULATION**	The simulation allows risk analysis and helps in decision making by modeling complex scenarios probability [4].
*** HAZOP**	The method HAZOP (Hazard & Operability) is a qualitative study that allows us to know what the consequences are if you change a system operating conditions [17]. A further step in the study, would be to search the range of deviations from the nominal values of design, in which the equipments and the system work properly.
*** MARKOV**	Markov analysis allows analyzing the actual movement of a variable, to predict its future movement whose probabilistic behavior is determined solely by the current status [17]. It is based on the analysis of the reliability and availability. The system reliability behavior is represented using a transition diagram, which consists of a set of discrete states in which the system can be, and defines the rate at which transitions between states can occur (failures and repair). The Markov model is analyzed to determine measures such as the probability of being in a given state in an instant of time, the transition time of the system to another state and the expected number of transitions between states: for example, represents the number of failures and repairs.
*** MONTE CARLO**	The Monte Carlo simulation has been used as an alternative to exact mathematical models or even the only means of estimating solutions for complex problems [26]. It is a quantitative technique that uses statistics and computers to imitate, through mathematical models, the random behavior of real systems (not dynamic), systems whose state is changing over time, using discrete event simulation or simulation continuous systems.
*** RBD**	In reliability, a block diagram (RBD) is a graphical representation of the components / subsystems of the system and their relationship from the standpoint of reliability [4].

V. EVALUATION AND COMPARISON CRITERIA

To analyze in detail a software tool supporting the RCM methodology, we have to consider and to assess issues that may determine its functions and its relevance to the specific needs in each case [27, 11]. In this section we define, classify and describe a set of criteria to consider for effective and efficient implementation of RCM methodology in the company by supporting software.

Once it is understood the concept and philosophy of RCM methodology and it is reviewed the various software structures supporting its implementation, then we propose a set of criteria for evaluating any RCM software tool and to facilitate comparison with other software packages for the same purpose. Therefore, it is intended to provide a methodology for evaluating RCM software tools for comparing different tools using a standard maturity model [28].

The first objective to quantify or measure the degree of alignment of the software tool with the RCM methodology (seven questions, Table 1), if follows the same logical sequence proposed methodology. The second objective is to evaluate functional aspects which, although not directly related to the methodology should be taken into account to analyze the functionality and overall operational RCM software. Consider these criteria will prevent functional deviations that may arise in the use of the tool (with respect to the application of RCM methodology) and ensures that the selected tool has features that ensure the efficiency of use, reliability, maintainability and support.

In the proposed evaluation system (Table 4, 5, 6), the criteria are classified into three functional blocks, linked all together. These blocks are shown in Figure 1:

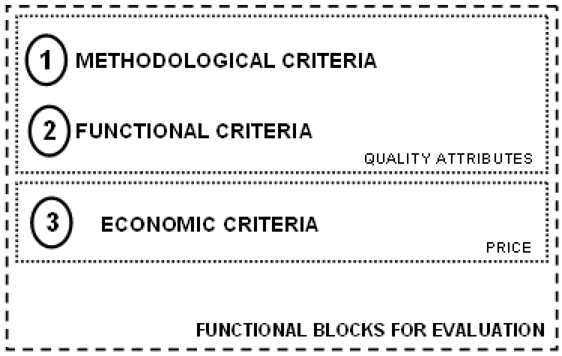

Fig. 1 Ranking of the Criteria Constituting the Proposed Evaluation System

According to [29], a product could be evaluated according to quality attributes and price. The quality attributes include reliability, scalability, service, availability, connectivity, performance, among others. Price attributes include cost, maintenance cost, among others. Based on these attributes, the evaluation criteria of RCM software have been classified into two blocks, attributes of quality and price.

The quality attributes are composed of two sets of criteria: methodological criteria and functional criteria. Methodological criteria integrate all technical aspects of the RCM methodology [12], thus the criteria that make up this block follow a logical sequential order to measure the degree of loyalty software to

the RCM methodology. The functional criteria encompass all aspects not directly related to the RCM methodology. Different contributions describe some of these aspects. For instance, according to [27], there are functional criteria that directly affect product quality, such as computational aspects, logistics and technical service.

Price attributes consist of all aspects related to the total cost of the product, to be considered in the overall evaluation of the tool. Below are listed the criteria classified by functional block using tabular format for ease of reading, comparison and interpretation.

BLOCK 1: METHODOLOGICAL CRITERIA

TABLE IV. METHODOLOGICAL CRITERIA

	MATURITY LEVELS			
CRITERIA	**LEVEL 1**	**LEVEL 2**	**LEVEL 3**	**LEVEL 4**
1.1 Definition of the natural working team and planning meetings.				
1.2 Ranking based on asset criticality.				
1.3 Relation criticality - risk factor.				
1.4 Definition / description of the equipment.				
1.5 Definitions of operational context.				
1.6 Definitions of the system and subsystems division.				
1.7 Definition of functions and performance standards.				
1.8 Definition of functional failures.				
1.9 Definition of failure modes.				
1.10 Definition of the qualitative impact of the failure mode.				
1.11 Definition of quantitative impact (economic) failure mode.				
1.12 NPR indicator based on occurrence, detectability & severity.				
1.13 Definition of the root causes that lead to failure.				
1.14 Maintenance strategies definition (corrective / preventive).				
1.15 Identification of maintenance strategies using RCM logic.				
1.16 Estimation of PF interval for the CBM activities				
1.17 Definition of maintenance activities to hidden failures.				
1.18 Evaluation of reliability using indicators: MTTF, MTTR, etc.				
1.19 Calculation of the current cost of maintenance.				
1.20 Calculation of indicators defined by the user.				
1.21 Traceability of indicators.				
1.22 Follow-up recommendations for improvement.				
1.23 Calculation of the optimal policy of maintenance.				
1.24 Simulation				
1.25 Definition of critical spares.				

BLOCK 2: FUNCTIONAL CRITERIA

TABLE V. FUNCTIONAL CRITERIA

	MATURITY LEVELS			
CRITERIA	**LEVEL 1**	**LEVEL 2**	**LEVEL 3**	**LEVEL 4**
2.1 Ergonomics. Standard interface and intuitive operation.				
2.2 Computational Performance.				
2.3 Graphical display of data.				
2.4 Export / import data.				
2.5 Security. Access management and profiles.				
2.6 Integration with other systems and databases connection.				
2.7 Type of architecture.				
2.8 Support at every stage of RCM analysis.				
2.9 Products of the tools / modules available.				
2.10 Prior demonstration.				
2.11 On-line help, telephone and / or face.				
2.12 Software Updates.				
2.13 Training service.				
2.14 Consultancy / Advice				
2.15 Technical support / Timeouts.				
2.16 Market Presence.				

BLOCK 3: ECONOMIC CRITERIA

TABLE VI. ECONOMIC CRITERIA

CRITERIA	MATURITY LEVELS LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
3.1 Deployment Requirements.				
3.2 Cost of the product.				
3.3 Costs of installation.				
3.4 Cost of annual maintenance.				
3.5 Cost of updates.				
3.6 Training costs.				

One of the benefits of the RCM software tool evaluation using the proposed methodology is the possibility of later comparison with other tools evaluated following the same methodology. In this it is necessary to define a common weighting system.

Different sources [30, 31, 28], describes an evaluation method based on maturity models to measure and control the various software capabilities. The SEI (Software Engineering Institute) proposes the model CMMI (Capability Maturity Model Integration) as a reference for determining the ability of the software processes of an organization and defines the method SCAMPI (Standard CMMI Appraisal Method for Process Improvement) for evaluation. At the time of establishing the process maturity of an organization, CMMI identifies five levels of capacity, which define an ordinal scale to represent the evolution of the software process from a chaotic initial level to a state of continuous improvement (mature).

In the case of the RCM software evaluation tools, we can estimate the level of maturity of software using the SCAMPI appraisal method. This method [28] allows establishing a functional block classification in four levels of maturity, depending on the criteria satisfied by the RCM software under study. For a block has a certain level of maturity, must meet the assessment criteria associated with that level and previous levels (Figure 2).

Fig. 2 Levels of Maturity for the Assessment of RCM Software

The maturity level classification of the various functional blocks makes it possible to compare different software tools RCM. Each functional block, after evaluation, you will get a level of maturity in terms of satisfying the criteria and can be compared with the level of maturity achieved by other software. The meaning of each maturity level is:

- Level 1: The software does not meet the minimum criteria required.
- Level 2: the software meets the minimum criteria required.
- Level 3: the software has largely met the minimum standards required, although there are no significant weaknesses.
- Level 4: The software meets all the criteria required to be no significant weakness.

Following the RCM methodology [12], we have determined the different levels of maturity for the block of methodological criteria (Table 4) in Table 7, however, the maturity levels of Block 2 and 3 must be defined by the organization or agent evaluator software, since they are subjective and can change depending on the specific needs of each case.

As mentioned above, Table 7 presents a maturity model. This model is a result of the definition of the different maturity levels according to the RCM methodology and those elements of that methodology which are embedded (or not) in different RCM tools. In this way, a RCM tool maturity evaluation can be easily accomplished [22, 24, 25]. Criteria selected to define Level 1 of maturity can be only understood as an example. We do establish reasonable minimum tool requirements in Level 2 of the model, however in Level 1 we have represented a typical existing scenario found in several poor RCM implementation packages.

TABLE VII. MATURITY MODEL

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
1.1 Definition of the RCM review team and planning meetings.			●	●
1.2 Ranking based on asset criticality.		●	●	●
1.3 Relation criticality - risk factor.				●
1.4 Definition / description of the equipment.	❖	●	●	●
1.5 Definitions of operational context.			●	●
1.6 Definitions of the system and subsystems division.	❖	●	●	●
1.7 Definition of functions and performance standards.		●	●	●
1.8 Definition of functional failures.			●	●
1.9 Definition of failure modes.	❖	●	●	●

1.10 Definition of the qualitative impact of the failure mode.		●	●	●
1.11 Definition of quantitative impact (economic) failure mode.			●	●
1.12 NPR index based on occurrence, detectability & severity.				●
1.13 Definition of the root causes that lead to failure.	❖	●	●	●
1.14 Maintenance strategies definition (corrective / preventive).	❖	●	●	●
1.15 Identification of maintenance strategies using RCM logic.			●	●
1.16 Estimation of PF interval for the CBM activities				●
1.17 Definition of maintenance activities to hidden failures.		●	●	●
1.18 Evaluation of reliability using indicators: MTTF, MTTR, etc.	❖	●	●	●
1.19 Calculation of the current cost of maintenance.		●	●	●
1.20 Calculation of indicators defined by the user.				●
1.21 Traceability of indicators.		●	●	●
1.22 Follow-up recommendations for improvement.			●	●
1.23 Calculation of the optimal policy of maintenance.				●

VI. Conclusion

This article has been made, first, an analysis and description of the different types of structure and functions provided by maintenance software that support the implementation of the RCM methodology.

They have observed three types of structures in the RCM software and described the functionality offered. In general, these software can also perform other types of analysis useful for decision making in the field of reliability and overall management of maintenance. Then, there has been a description and listing of major complementary functions (additional modules) that usually have the RCM software.

Using a descriptive tabular analysis, we have defined all the aspects related to the structure, capabilities and performance of the three possible platforms that a RCM software may present. A first conclusion drawn is that there are three types of organizational structures in the field of software tools RCM: modular, integral and mixed.

Another noteworthy aspect in this type of software tools is the ability to integrate with the existing database in the organization (CMMS EAM and other systems). The systems integration and implementation simplicity are and will be key factors in the future development of this software and its analytical evaluation by an external agent.

This article proposes a methodology for evaluating RCM software tools based on a set of criteria for evaluating the suitability of the tool in areas such as: RCM methodology alignment; organizational needs fulfilment, software performance and software implementation at the operational and organizational levels. The proposed evaluation system facilitates and standardizes the process of software analysis and comparison between RCM software tools.

Then, in order to make an objective comparison between different RCM software tools we have defined a weighting system based on maturity levels per area or block. Thus, each block of criteria will get a level of maturity (1-4) according to their suitability to the criteria defined for each of them, each level corresponding to a specific qualitative rating.

As future research lines, it is suggested to deepen in this field developing, for instance, a real evaluation of different RCM software tools by the presented methodology. It could be a real case where the maturity levels of Block 2 and 3 must be defined by the organization or agent evaluator software, since they are subjective and can change depending on the specific needs of each case. However, this target exceeds the limits of this paper which only aims to show an evaluation methodology.

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